Chapter 10
Communication System

10-1. General

a. Types of systems available. Reliable communication systems are vital to the operation of every power plant. Voice communication is a necessity at all plants and code-call signaling is generally required for accessing personnel at large power plants. Additional dedicated communication systems are required for telemetering, SCADA, and for certain types of protective relaying. Communications media available for power plant application include: metallic cable pairs; leased telephone lines; power line carrier (PLC); radio frequency communications, including two-way land mobile (TWLM) radio and terrestrial microwave (*MW*); fiber optics; and satellite communications.

b. Regulatory requirements. The Federal Information Resource Management Regulation (FIRMR), as administered by the General Services Administration (GSA), requires GSA approval for all communication systems (other than military) used by agencies of the Federal Government. The GSA contract with common carriers guarantees carriers access to Government long-distance communication business. The service to provide long-distance communications is known as FTS 2000. The GSA requires its use by Government agencies, unless the agencies are able to prove, on a case-by-case basis, that the FTS 2000 service will not meet its needs. For information on the FIRMR, and approval documentation needed, contact the Corps of Engineers Information Management Office.

10-2. Voice Communication System

a. Telephone service. Normally, general internal and external telephone communications are provided through public switched telephone network services installed and operated by the serving telephone company. The equipment (including telephones) is leased from the telephone company. The communication circuits provided by a commercial telephone operating company include connection to local exchange, long distance, WATS, and FTS 2000 telephone service. Telephone pay stations in visitor areas should be provided for public convenience.

b. Plant equipment. The distributing frame and switching equipment for any commercial systems should be installed in a location near the control room where it can be included in the air conditioning zone for the control room. A preferred AC circuit should be provided for the commercial equipment.

c. Telephone locations. To ensure adequate telephone access, sufficient telephone outlets should be provided in the office area, the control room, the generator floor at each unit, the switchgear area, the station service area, and the plant's repair shops. A telephone outlet should be provided in each elevator cab. Circuits to telephone outlets are provided by metallic cable pairs. Telephone wiring inside the plant, from the telephone company switching equipment location to the location of the various instruments, is provided by the Government and included in the powerhouse design. Embedded conduits dedicated to telephone use are provided for the cables.

10-3. Dedicated Communications System

a. General. Dedicated communications systems are provided in the plant for code call systems, SCADA systems, protective relay systems, and for voice communications to the dispatching centers and substations of the power wheeling entity (either Federal Power Marketing Agency (PMA) or non-Federal utility). Communications media for performing these functions can be either leased commercial circuits, power line carrier (PLC), radio frequency communications, fiber-optic cable, satellite communications, or a combination of these media.

b. Code call system. Generally, code-call facilities are provided at all plants permitting paging of key personnel. A separate, Government-owned code-call system should be provided when leased telephones are used, so maintenance of the code call will not depend on outside personnel. An automatic repeating type code-sending station should be located on the control room operator's desk or console.

c. Utility telephone systems.

(1) Voice communications facilities for power plant control and dispatch use are typically provided through a utility or Federal PMA-owned telephone system. If it is a Federally owned system, the FIRMR requires the use of FTS2000 for inter-local access and transport area service, unless an exception is granted. In some instances, the major use of the communication channel has been the determining factor in whether Government ownership of the system is permitted. If the major use of the service is technical; that is, plant operating and control information, then Government ownership has been approved.

(2) The telephone system should provide access to dispatching voice channels of the utility. Generally, dial automatic telephone switching facilities provide a system-wide network of voice circuits which are automatically switched to permit calling between generating stations, major substations, and control centers. Some plants have used leased private line service for communications circuits which are provided by a commercial telephone company's common carrier for the sole use of the plant. These circuits are provided on the cable and other transmission facilities of the carrier, but should not be connected directly to the network switching systems of the carrier or telephone operating company.

d. Leased circuits.

(1) Leased commercial circuits can be used for voice communication circuits as described in paragraph 10-3*c*. Voice grade communication channels are required and are supplied either through a dial or a dedicated system, with dedicated channels being the preferred alternative. The basic voice-bandwidth private line channel is an AT&T system "Type 3002 unconditioned" channel. Other commercially available private line data channel services are Digital Data Service (DDS) and Basic Data Service (BDS). These latter services offer digital interconnectivity through a wide range of data transmission speeds.

(2) Leased circuits have been used for plant protective relaying circuits with mixed results. Generally, it is better to own the communication facility if it is used for vital high-speed relaying service. Some of the past problems with leased channels have been loss of service because of unannounced maintenance activity by the leasing agency, failure of the system, rerouting of the service because of maintenance or construction activity, and accidental circuit interruption by personnel looking for trouble on other circuits. Typically, a leasing agency's operating and maintenance personnel do not understand the level of reliability necessary for relaying circuits.

(3) Leased circuits have been used for SCADA system control of plants and substations. Here, too, the results have been mixed. For short distances where the leasing agency can provide a direct link between the local and remote station, results have been good. Where the circuit has been routed through a central office, the reliability of service has in a number of cases not been of the level of reliability needed for data acquisition and control. The lack of reliability is apt to be more of a problem if the plant is in a remote location and served by a small telephone company. Use of leased facilities has to be considered on a case-by-case basis, and all of the influencing factors need to be considered, including the service record of the proposed leasing agency.

e. Power line carrier.

(1) A "basic" PLC system consists of three distinct parts:

(a) The terminal assemblies, consisting of the transmitters, receivers, and associated components.

(b) The coupling and tuning equipment, which provides a means of connecting the PLCs terminals to the high-voltage transmission line.

(c) The high-voltage transmission line, which provides the path for transmission of the carrier energy. High-voltage coupling capacitors are used to couple the carrier energy to the transmission line, and simultaneously block 60-Hz power from the carrier equipment.

(2) Most transmitter/receiver equipment is installed in standard 19-in. radio racks inside cabinets located near the plant control room. Carrier frequency energy is conducted out of the plant by coaxial cable to the high-voltage transmission line tuning and coupling equipment. PLC equipment power requirements are supplied from either 48-V or 125-V DC derived from the station battery or a dedicated communications battery source. If a PLC system is to be provided, routing provisions for the wire and cables needed must be included in the plant design.

(3) Power line carrier communication systems have found extensive use for relaying, control, and voice communications in Europe, and in some areas of the United States. Their use is less popular in the United States, apparently because of the availability of radio frequency spectrum, and utility-owned communication systems apart from the power transmission facilities. PLC bandwidth is limited because of its operating frequencies and the transmission medium. Its transmission path is susceptible to noise from arcing faults, interruption by ground faults and other accidents to the line, and weather. If other reliable communication means are available at a reasonable cost, it would probably be advantageous to avoid the use of PLC.

f. TWLM radio.

(1) There is some very limited use of TWLM radio in SCADA systems using the 150-MHz and 450-MHz frequency bands. Mostly, it is used for data links with

small distribution system remote terminal units (RTUs) that are not critical to power system operation and not economical to serve with a dedicated or dial phone line. More common usage of TWLM media is Multiple Address System (MAS) radio, which was developed specifically for SCADA applications.

(2) MAS essentially emulates telephone leased line circuits. The system consists of a transmitting master station and multiple remote stations using frequencies in the 900-MHz and above range. Its use is not practical for hydro plant data acquisition and control, but it should be considered if a hydrometeorological (hydromet) data system is to be built in the plant area, and hydromet data gathering controlled from the plant. It could also be considered for use in pumping plants that are under the surveillance of the plant staff.

g. Microwave radio.

(1) Microwave radio consists of transceivers operating at or above 1,000 MHz in either a point-to-point or point-multipoint mode. Microwave radio systems have both multiple voice channel and data channel capabilities. Microwave systems use either analog (Frequency Division Multiplex [FDM]) or digital (Time Division Multiplex [TDM]) modulating techniques. The trend is towards digital modulating systems because of increasing need for high speed data circuits and the superior noise performance of TDM modulation. Analog radio is considered to be obsolete technology, and it is likely that analog radio will not be available in the future.

(2) Microwave radio energy is transmitted in a “line of sight” to the receiving station, and the useful transmission path length varies depending on the frequency. Whether a microwave system can be used at all depends on factors beyond the scope of this manual, including the terrain features between end points of the system. However, in general it can be said that useful systems of any length will require one or more repeater stations located at such points on the radio path that they can be seen from the stations they receive from, and the stations they transmit to. Such repeater locations may be remote from any utility services, and in fact may not even be near a road. Site access, real estate acquisition, construction on the site, environmental impacts, and maintenance of the station need to be carefully considered before a final decision is made to use microwave communications. FIRMR requirements must also be considered.

(3) Microwave radio has found some short-range use in providing communication between the powerhouse and its switchyard, if the switchyard is located a mile or more away from the plant and the plant ground mat is not solidly connected to the substation ground mat. The danger of voltage rise on control and communication cables between plant and substation during fault conditions is well known. Microwave radio is particularly useful here in providing isolation from noise and dangerous voltage levels on these circuits, since with the radio there is no metallic connection between the terminals. Note, however, that a fiber-optic carrier system will also offer the advantages of a nonmetallic connection, and may be more economical.

(4) Generally, microwave radio transceiver equipment accommodations in the plant are handled in the same manner as PLC equipment accommodations. However, distance to the antenna, antenna location, and wave guide routing must be considered. The effects of icing on the antenna may require a power source for the antenna location to provide antenna heating.

h. Fiber-optic cable.

(1) A fiber-optic cable system consists of a terminal with multiplexing equipment, and a transmitter and receiver coupled to fiber-optic light conductors that are routed to the other terminal, which also has a receiver, transmitter, and multiplexing equipment. Because the transmission medium is nonmetallic, it offers the advantage of electrical isolation between terminals and immunity from electromagnetic interference.

(2) Because of the frequency of the transmitting medium, light, the fiber-optic system offers a bandwidth that can carry a great deal of data at very high speeds. The glass fibers are small and delicate, so should be enclosed in a protecting sheath. For communication systems external to the plant, right-of-way acquisition may be a problem since the fiber-optic cable does require routing just as a copper cable would.

(3) There are many possible ways of routing the fiber. It is possible to obtain high-voltage transmission line cable with fiber-optic light conductors incorporated in its construction. The fiber-optic light conductor can also be underbuilt on the transmission line to the plant. For long transmission distances, the fiber-optic system requires repeaters. The transmission distance before repeaters are needed has been steadily increasing because of the development effort in this technology. It offers great possibilities for external plant communication systems and should be considered in each case.

(4) Probably the most important application for fiber-optic technology is for a Local Area Network (LAN) within the plant. Its large data capacity, high rate of data transmission speed, and immunity from electromagnetic interference make the LAN an ideal medium for communication among the elements of distributed control systems within the plant. The technology is developing at a very rapid rate, and standards are coming into being, such as the Fiber Distributed Data Interface (FDDI), allowing its use with a variety of devices.

i. Satellite communications. Satellite communication systems have not been applied to Corps plants because of cost and convenience. The Corps has made use of a satellite time signal to provide a uniform time signal to plant control systems, but that signal is available to any suitable receiver without charge. Though this alternative appears to have many attractive advantages, the utility industry in general has yet to implement widespread use of private networks based on satellite technology.

10-4. Communication System Selection

a. Systems external to the plant. In most cases, the choice of the communications media used for dispatching and remote plant control and monitoring will not be a responsibility of the plant designer. The power-wheeling entity for the plant's power production will use systems and equipment compatible with the utility's "backbone" communications network. It is the plant designer's responsibility to ensure that adequate provisions are made for the communication system's terminal equipment and to ensure that plans and specifications prepared for powerhouse equipment and systems address special requirements for voice and data transmission as dictated by the external communication system. Coordination with the system owner will be required to ensure compatibility.

b. Design considerations. Other design considerations include interface requirements for data circuits, as imposed by the communication utility due to FCC regulations, and ground potential rise protection requirements for plant terminals of the metallic circuits used for voice, data, and control. In cases where the project scope includes development of a communications network, a comprehensive study should be made of alternatives available including system life-cycle costs to determine the most technically appropriate and cost-effective scheme to achieve successful communications system integration. EPRI EL-5036, Volume 13, provides guidance on criteria to evaluate if the project scope includes development of a communications network.

c. Internal plant communications. Internal data circuits (LANs) will be included with the data acquisition and control equipment that uses them, but the designer should consider that fiber-optic technology will probably be used. Also, for large plants to be staffed with administrative and maintenance personnel, a network of microcomputers may be added after the plant is in operation. The plant designer should provide facilities for routing network data highways between offices, maintenance shops, and the control room.